Carbon dioxide transport

INTENDED LEARNING OBJECTIVES (ILOs)

By the end of this lecture the student will be able to:

1. List forms in which carbon dioxide is transported in the blood.
2. Illustrate the carbon dioxide dissociation curve: shape and shifts
3. List the typical values of carbon dioxide content and partial pressures in blood
4. Describe Gas movement in pulmonary and systemic capillaries; chloride shift
5. Compare Bohar and Haldane effects

CARBON DIOXIDE (CO_2) TRANSPORT

- Arterial blood contain 48 ml CO_2 / 100 ml blood at a tension of 40 mmHg
- Venous blood contain 52 ml CO_2 / 100 ml blood at a tension of 45 mmHg.

So every 100 ml blood carries 4 ml from tissues which known as **tidal CO_2**

Tidal CO_2

It is the amount of CO_2 added by the tissues to every 100 cc of arterial blood to be changed into Venus blood (4 ml of CO_2)

This tidal CO_2 is transported as:

1) **Physical 7%** dissolved in plasma
2) **Chemical 93%:**

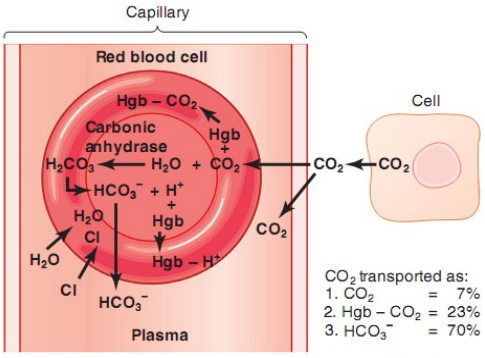


Figure 41-13. Transport of carbon dioxide in the blood.

a) Carbamino compounds 23%: CO_2 combined with Hb and plasma proteins

b) HCO_3^- 70%: CO_2 in the blood reacts with water to form carbonic acid.

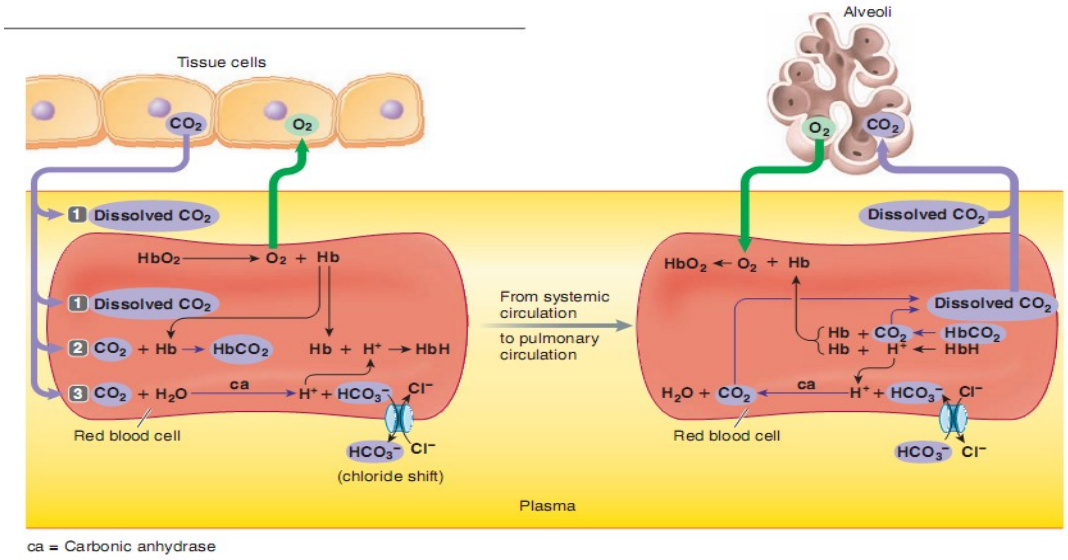
CARBON DIOXIDE TRANSPORT

Carbonic anhydrase enzyme which is found in many cells including RBCs, accelerates the reaction:

$CO_2 + H_2O$ H_2CO_3

CHLORIDE SHIFT

Movement of Cl^- ions into or out of RBCs, to compensate for the movement of HCO_3^- ions and to maintain electrical neutrality.



Effect of chloride shift

CO_2 entering the blood is converted to HCO_3^- in RBCs by carbonic anhydrase enzyme, most of this HCO_3^- moves out of RBC into plasma in exchange for Cl^- to maintain electrical neutrality.

So net result of Cl^- shift:

3 substances, which increase in both RBCs and plasma:

1-CO_2 2- Carbamino compounds 3-HCO_3^-.

2 substances that increase in RBCs and decrease in plasma:

1-$C1^-$ 2-H_2O.

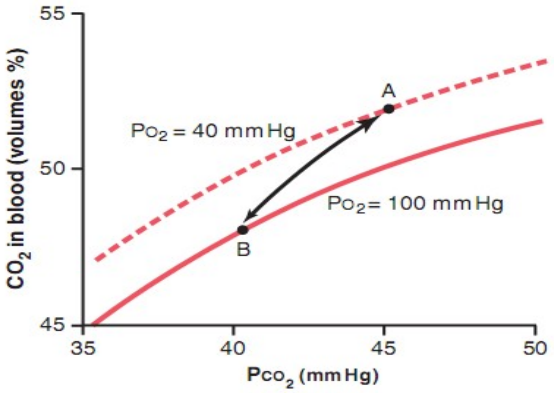
So *hematocrit value* is more in *venus blood* due to increase size of RBCs.

CARBON DIOXIDE TRANSPORT

PHYSIOLOGICAL CO_2 DISSOCIATION CURVE

It represent the relationship between total CO_2 content and PCO_2

It is the line which connects between:



Point A (Venous blood):

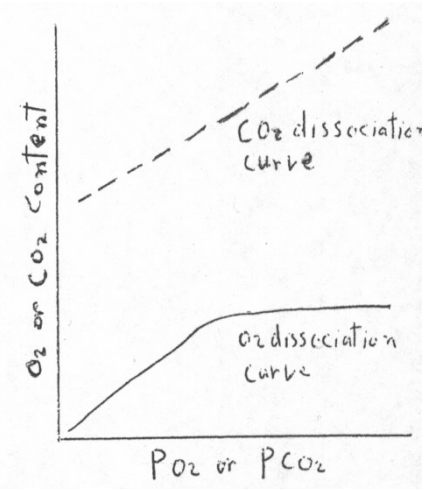
PCO_2 = 45 mmHg

CO_2 content = 52cc

Point B (arterial blood):

PCO_2 = 40 mmHg.

CO_2 content = 48 cc



Comparison between O_2 and CO_2 curves:

- CO_2 content curve is **linear.**
- The CO_2 content of blood is **more than twice** the O_2 content of the blood because of greater solubility in blood.
- CO_2 curve is much **steeper** i.e. much larger changes occur for the same changes in partial pressure.
- Over-ventilation of parts of lung can remove CO_2 to compensate for the under-ventilation of other parts of lungs (such **compensation** can not occur for O_2).

O_2 , CO_2 and H^+ interaction

Bohr effect:

It is the effect of CO_2 and H^+ on Hb binding with O_2

Binding of CO_2 and H^+ with Hb will decrease Hb affinity to O_2, Shiftting of oxyhaemoglobin curve to the right

Haldane effect:

It is the effect of O_2 on Hb binding with CO_2 and H^+

Increasing Hb oxygen (HbO_2) saturation decreases blood CO_2 binding capacity

SUGGESTED TEXTBOOKS

1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 41 , from page 534 to 536

2. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 35, from page 643 to 641

3. Lauralee Sherwood Human Physiology: From Cells to Systems, Ninth edition 2016. CENGAGE, chapter 13, from page 476 to 477